Changing Fruit and Vegetable Consumption among Children: The 5-a-Day Power Plus Program in St. Paul, Minnesota

ABSTRACT

Objectives. A randomized school-based trial sought to increase fruit and vegetable consumption among children using a multicomponent approach.

Methods. The intervention, conducted in 20 elementary schools in St. Paul, targeted a multiethnic group of children who were in the fourth grade in spring 1995 and the fifth grade in fall 1995. The intervention consisted of behavioral curricula in classrooms, parental involvement, school food service changes, and industry support and involvement. Lunchroom observations and 24-hour food recalls measured food consumption. Parent telephone surveys and a health behavior questionnaire measured psychosocial factors.

Results. The intervention increased lunchtime fruit consumption and combined fruit and vegetable consumption, lunchtime vegetable consumption among girls, and daily fruit consumption as well as the proportion of total daily calories attributable to fruits and vegetables.

Conclusions. Multicomponent school-based programs can increase fruit and vegetable consumption among children. Greater involvement of parents and more attention to increasing vegetable consumption, especially among boys, remain challenges in future intervention research. (*Am J Public Health.* 1998;88:603–609)

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Introduction

Given the abundance of affordable food in the United States, it is notable that consumption of fruits and vegetables is generally low and that this low intake is associated with higher rates of cancer in many sites, including the colon, prostate, lung, esophagus, stomach, bladder, and pancreas.[1–4] Five servings a day of fruits and vegetables are recommended as a minimum for adults and children more than 2 years old.[5] Only 32% of adults consume the recommended level.[6] Likewise, children and adolescents consume fewer than 5 servings a day.[7,8] One study showed that among children 6 to 11 years of age, only 16% ate 5 or more servings a day.[8] Moreover, French fries constituted nearly 25% of all of the vegetables consumed by young people.[8] Low percentages of fruits and vegetables are even more evident in low socioeconomic groups, in which cancer incidence among adults is higher.[7,9–11]

In 1991, the National Cancer Institute (NCI), in collaboration with the Produce for Better Health Foundation, established the national 5-a-Day for Better Health Program to encourage Americans to eat 5 or more servings of fruits and vegetables each day.[12] Research on interventions in schools was seen as important by the NCI, since young people's consumption of fruits and vegetables is low and dietary patterns appear to be established and consolidated in childhood and adolescence.[13–16] School-based interventions have shown considerable promise in promoting healthful dietary behaviors among children, particularly interventions involving multiple components.[16–20]

The 5-a-Day Power Plus program was funded by the NCI with the goal of increasing fruit and vegetable consumption among fourth- and fifth-grade children in the St. Paul, Minn, schools. The study was a randomized field trial of 20 elementary schools in the district. The study augmented research in school-based interventions and dietary change by using a sophisticated research design, creative interventions, and converging evaluation methods, including direct observation of food intake, in an ethnically diverse urban population of children.

Methods

Subjects

The St. Paul Public School District, in the urban Twin Cities metropolitan area of Minnesota, is 1 of 2 school districts in the state in which nearly half of the students are of non-Caucasian ethnic backgrounds. Twenty elementary schools in the district were recruited to participate and agreed to all aspects of the study, including randomization to condition. The primary study cohort consisted of fourth-grade students in the 1994/95 school year in these 20 schools.

Design

The 5-a-Day Power Plus study was a randomized community trial with schools

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as the unit of assignment. The 20 recruited schools were matched on the basis of school size, ethnic makeup of the student population, and percentage of students participating in the free or reduced-price lunch program. This resulted in 10 matched pairs. Randomization occurred within pairs, with 10 schools each being assigned to the intervention or delayed program condition.

Baseline data were collected from fourth-grade students in January and February 1995. The fourth-grade intervention took place in March through May 1995. The fifth-grade intervention took place between October 1995 and January 1996. Follow-up data were collected between late January and March 1996.

Intervention Program

The 5-a-Day Power Plus intervention program was guided by social learning theory[19,21–23] and prior research on changing children's dietary behavior.[17,20,24] The intervention consisted of 4 components: behavioral curricula in the fourth and fifth grades, parental involvement/education, school food service changes, and industry involvement and support. Each of the components was designed to be complementary to the other components. (Additional details on the intervention components and the theoretical model guiding them are available in an appendix from the authors.)

Two curricula were written for the fourth- and fifth-grade students: "High 5" and "5 for 5." Each of these curricula included sixteen 40- to 45-minute classroom sessions implemented twice a week for 8 weeks. Skill-building and problem-solving activities were included, as well as snack preparation and taste testing. The curricula introduced new role models in the form of comic books in High 5 and an adventure story in 5 for 5. Students formed teams during both curricula; team competition to eat fruits and vegetables during lunch was a central component of each program. Students were rewarded small prizes on an individual student and team basis at the end of each program. All fourth- and fifth-grade teachers took part in a 1-day training session prior to implementation of the curricula.

The fourth-grade parental involvement program was a modification of the "home team" approach[25] and consisted of 5 information/activity packets brought home by the students. Parents and students participated in these activities and then signed a return card that was brought back to the classroom and used as an entry for a classroom drawing.

The fifth-grade parent program consisted of 4 snack packs that students brought home. The snack packs were prepared by the school food service and contained food items (including fruits and vegetables) for the students to prepare as a snack for their families at home. Included in each snack pack was a return card to be signed by the parent and entered into a classroom drawing.

The food service intervention encouraged selection and consumption of fruits and vegetables at school lunch via 4 strategies: (1) point-of-purchase promotion of fruits and vegetables using characters and messages from the classroom curricula, (2) enhancing the attractiveness of fruits and vegetables that were served every day to students at school lunch, (3) increasing the variety and choice of fruits and vegetables available to students, and (4) providing an additional fruit item on days when a baked dessert was served. Sample trays and signs showed students the available choices of fruits and vegetables each day.

The food service intervention was offered throughout the spring 1995 and fall 1995 semesters. All food service staff attended a 2-hour training session before each curriculum. The session reviewed the implementation of the food service intervention strategies and introduced the curricula and parental involvement components, particularly the classroom taste testing and snack packs.

The industry component of the intervention included support from the 72-member Minnesota 5-a-Day Coalition. Beckman Produce Inc, a St. Paul–based supplier of produce, provided fruits and vegetables for the classroom taste testing, home snack packs, and school lunch. A Beckman Produce executive also made a 30-minute presentation on fruits and vegetables to each of the 30 fifth-grade classrooms in the 10 intervention schools. Nash Finch Company, Dole Food Company Inc, and other Minnesota 5-a-Day Coalition partners provided additional educational and incentive materials.

Measures

Program implementation. Process measures were developed to monitor the level of participation in the various intervention components and the implementation fidelity of the interventions. Measures included training participation rates, written feedback from participants, and direct observations of classrooms and the lunchroom.

Selection of students for dietary measures. A simple random sample of 34 students in each school was obtained in order to ensure twenty-seven 24-hour recalls and matched lunchroom observations per school at baseline. The chosen students were instructed on how to keep a 24-hour nonquantified food record.[26] They were also observed at lunch that same day and provided 24-hour recalls the next day. Those students who completed the 24-hour recall at baseline were recruited a year later for the follow-up lunchroom observation and 24-hour recall.

24-hour recalls. Methods for the 24-hour recall were adapted from those used in the Child and Adolescent Trial for Cardiovascular Health.[20] The interviewers entered students' information directly into a laptop computer using the Nutrition Coding Center's software and database.[27] These methods have been shown to provide valid estimates of group intake, although students may, on an individual level, overestimate their fruit intake.[26,28,29] Servings of fruits and vegetables consumed were calculated on the basis of total grams of food (according to the practice at the time of the Cancer Prevention Research Unit at the University of Minnesota[30]).

Student lunchroom observations. The chosen students were observed during school lunch on the day they were trained to keep the 24-hour food record. Using methods described elsewhere,[26] specially trained observers watched these students from a distance and recorded all items eaten at lunch and their portion size. The lunchroom observations were processed in exactly the same manner as the full 24-hour recalls (i.e., through use of the Nutrition Coding Center database).

Parent telephone survey. The parents of the students who completed the 24-hour recall were invited to complete a 15-minute telephone survey within 2 months of the school survey. All telephone interviews were conducted by specially trained staff. The parent (or guardian) most responsible for food preparation was asked questions related to fruit and vegetable consumption, both for him- or herself and for his or her children. Six items and scales (discussed in the results section) were examined in this study.

Health behavior questionnaire. All grade-appropriate students completed a group-administered health behavior questionnaire at baseline and follow-up. The questionnaire measured a variety of factors related to fruit and vegetable consumption as well as demographic and other variables. One staff member led the students through the instrument while others circulated in the classroom to answer questions. Nine individual items and scales (also discussed in the results section) were examined in this study.

Demographics. Age, sex, and race/ethnicity of the child were taken from school records. Race/ethnicity was classified as Caucasian, African American, Hispanic, Asian, Native American, or other. (Additional details on the measures are available in an appendix from the authors.)

Statistical Analysis

The 5-a-Day project involved a nested cohort design in which students at each school were followed over time as a cohort.[31,32] Mixed-model regression procedures, implemented via SAS PROC MIXED (version 6.11),[33,34] were used in analyzing data. For the main effect analyses, the posttest value of the dependent variable was regressed on condition; adjustment was made for the pretest value as well as demographic covariates. School was included as a random effect nested within conditions. Simulation studies have shown that this type of analysis provides a nominal type I error rate across a wide range of circumstances commonly observed in community trials.[35]

Possible effect modifications due to gender and racial/ethnic group were also assessed by adding terms to the fixed effects to represent the interaction between condition and strata and by adding terms to the random effects to represent the interaction between strata and school nested within conditions.

Results

Participation

In January 1995, 1750 fourth-grade students were enrolled in the 20 participating schools; of these students, 1612 (92.1%) completed the health behavior questionnaire. Of the remaining students, 3 (0.2%) refused, 108 (6.2%) were absent, and 27 (1.5%) had parents who refused. Six hundred fifty-seven students were selected at random for dietary measurement, and 652 (99.2%) were observed during lunchtime; 580 students returned their food records the next day, of whom 536 (81.6%) completed 24-hour food recalls. Parent surveys were attempted for each of these 536 children; 384 (71.6%) parents completed the interview, 115 (21.4%) were not English speakers and could not be interviewed, 29 (5.4%) could not be reached, and 6 (1.2%) refused to participate.

In January 1996, of the 536 children who had completed the 24-hour dietary recall at baseline, 441 (82.3%) completed recalls at follow-up, 67 (12.5%) were no longer attending the participating schools, 20 (3.7%) were missed as a result of absence, and 8 (1.5%) refused. Of the 384 families with completed baseline parent interviews, 324 (84.4%) completed the follow-up interview, 28 (7.3%) no longer had children attending the participating schools, 18 (4.7%) could not be located, and 14 (3.6%) refused.

Of the students enrolled in the fourth grade at baseline, 1.3% were Native American, 6.4% were Hispanic, 19.1% were African American, 25.2% were Asian American (largely Hmong), and 48.0% were White. More than 60% of the students received free or reduced-cost school lunches.

Baseline Comparability

Direct comparisons of the intervention and comparison conditions were made at baseline for all outcomes of interest from the lunchroom observations, 24-hour food recalls, health behavior questionnaire, and parent survey. Of the 46 variables examined, only 1 health behavior questionnaire variable was found to involve a significant difference between conditions. Thus, randomization was effective in creating comparable study groups at baseline.

Program Implementation

Training sessions were attended by 100% of the teachers. Structured staff observations of classes revealed that 78% to 85% of the curriculum activities were implemented as planned. Two thirds of parents returned cards indicating they had participated in at least one of the home team and snack pack lessons each year. Structured lunchroom observations indicated high levels of adherence to the school lunch practices promoted by the Power Plus program.

Lunchroom Observations

Lunchroom observations of students provided the most objective measure of the effect of the intervention on servings of fruits and vegetables. Servings were also calculated for fruits and vegetables per 1000 kcal to account for calories consumed. In addition, because of their relation to fruit and vegetable intake, vitamin A and vitamin C intake was assessed. As shown in Table 1, higher intakes were observed for all of these measures among students in the intervention schools relative to the comparison schools; all differences were statistically significant except for servings of vegetables and servings of vegetables per 1000 kcal.

Percentages of calories as fat and saturated fat were not primary outcomes but were of interest given their role in a healthy diet. There was no evidence of a significant difference between the two conditions.

There was a significant and favorable intervention effect among girls for vegetable consumption at lunch ($\Delta = 0.26$ servings, $P < .05$) but not among boys ($\Delta = 0.04$). The significant intervention effects observed for vitamin A and vitamin C were due only to effects among girls ($\Delta = 127.17$ mcg retinol equivalents, $P < .01$, and $\Delta = 13.73$ mg, $P < .001$, respectively). No differences in intervention effects by racial/ethnic groups were observed.

24-Hour Recalls

Significant intervention effects were seen for servings of fruits and vegetables per 1000 kcal, servings of fruit, and servings of fruit per 1000 kcal. In comparisons of observations and recalls, fruit and vegetable intake as a proportion of calories was found to be more accurately reported than unadjusted intake.[29] No significant differences were observed for vegetables, fruits and vegetables combined (but not adjusted for intake), or vitamin A or C, as shown in Table 2. However, a significant reduction in percentage of calories as fat was observed.

Further analysis revealed a significant interaction between condition and gender for vitamin C, with a favorable intervention effect among girls and no effect among boys. Three interactions were observed between condition and racial/ethnic group. The favorable trends for percentages of calories as fat and saturated fat reported in Table 2 appear to be largely due to favorable trends among Asians and African Americans, which were offset by unfavorable trends among the small number of Hispanics in the sample; no change was observed among White children. These data are shown in Table 3.

Health Behavior Questionnaire

The analyses of the health behavior questionnaire included 9 variables; differences between conditions at follow-up are shown in Table 4. Table 4 also provides information on questions, response options, Cronbach alpha coefficients, and possible response ranges for each variable. There were 4 significant results: more perceived teachers' support for eating fruits and vegetables, greater perceived need to eat fruits and vegetables, more reports of asking for fruits and vegetables, and more usual daily servings of fruits and vegetables. Notably,

TABLE 1—Lunch Dietary Intake of Fifth-Grade Students in St. Paul, Minn, at Follow-Up in Winter 1996: Direct Lunchroom Observations

Variable	Intervention Mean	Reference Mean	Difference	95% Confidence Interval	P
Primary					
Fruits and vegetables, servings	1.53	1.06	0.47	0.21, 0.72	.00
Fruits, servings	0.74	0.44	0.30	0.13, 0.46	.00
Vegetables, servings	0.79	0.63	0.16	–0.07, 0.39	.17
Fruits and vegetables, servings per 1000 kcal	3.02	2.19	0.83	0.41, 1.24	.00
Fruits, servings per 1000 kcal	1.67	0.95	0.72	0.31, 1.12	.00
Vegetables, servings per 1000 kcal	1.51	1.28	0.23	–0.09, 0.55	.15
Vitamin A, μg retinol equivalents	292.66	208.65	84.01	11.52, 156.50	.02
Vitamin C, mg	22.47	15.27	7.21	2.53, 11.89	.00
Secondary					
Total fat, % of kcal	32.03	31.78	0.25	–3.45, 2.94	.87
Saturated fat, % of kcal	12.38	12.71	–0.32	–1.92, 2.57	.77
Safety					
Total kcal	538.13	518.21	19.91	–90.69, 50.86	.56
Folacin, μg	46.67	44.91	1.76	–6.56, 10.08	.66
Iron, mg	3.00	3.08	–0.08	–0.55, 0.39	.71
Calcium, mg	330.69	348.50	–17.81	–67.03, 31.41	.46
Fiber, g	4.53	3.94	0.59	–0.10, 1.27	.08

Note. Values were adjusted for baseline measures, age, gender, and race/ethnicity. The student sample size was 424 for the primary variables. Intraclass correlation coefficients were .05 (fruits and vegetables), .03 (fruits), and .10 (vegetables). Differences between conditions are based on the F(1, 18) statistic.

TABLE 2—Total Dietary Intake of Fifth-Grade Students in St. Paul, Minn, at Follow-Up in Winter 1996: 24-Hour Recalls

Variable	Intervention Mean	Reference Mean	Difference	95% Confidence Interval	P
Primary					
Fruits and vegetables, servings	5.24	4.66	0.58	–0.15, 1.31	.14
Fruits, servings	2.75	2.13	0.62	0.10, 1.14	.02
Vegetables, servings	2.50	2.52	–0.02	–0.43, 0.48	.92
Fruit and vegetables, servings per 1000 kcal	2.82	2.41	0.41	0.07, 0.75	.02
Fruits, servings per 1000 kcal	1.51	1.16	0.36	0.05, 0.67	.02
Vegetables, servings per 1000 kcal	1.33	1.28	0.05	–0.30, 0.19	.65
Vitamin A, μg retinol equivalents	1118.18	955.72	162.47	–387.72, 62.78	.15
Vitamin C, mg	115.68	107.70	7.98	–24.44, 8.48	.32
Secondary					
Total fat, % of kcal	30.02	31.83	–1.81	–3.25, –0.37	.02
Saturated fat, % of kcal	11.72	12.31	–0.59	–0.20, 1.38	.13
Safety					
Total kcal	1914.61	2036.41	–121.80	–251.06, 7.45	.06
Folacin, μg	258.47	262.68	–4.21	–29.90, 21.47	.73
Iron, mg	13.09	13.76	–0.67	–1.94, 0.59	.28
Calcium, mg	1018.49	1116.10	–97.61	–189.14, –6.08	.04
Fiber, g	13.56	13.61	–0.05	–1.86, 1.76	.96

Note. Values were adjusted for baseline measures, age, gender, and race/ethnicity. The student sample size was 407 for the primary variables. Intraclass correlation coefficients were .03 (fruits and vegetables), .02 (fruits), and .02 (vegetables). Differences between conditions are based on the F(1, 18) statistic.

the students' perceptions of support from family, friends, and the school food service (cooks) showed no differences between conditions.

Parent Survey

Of the 6 variables examined from the parent survey, only 1 produced a difference between conditions: awareness of the 5-a-Day program. These outcomes, as well as details on the parent items, are shown in Table 5.

Discussion

The outcomes of the 5-a-Day Power Plus program provide evidence that multicomponent school-based behavioral programs can improve the health behaviors of children in schools and communities with considerable ethnic and socioeconomic diversity. The program increased lunchtime fruit consumption and combined fruit and vegetable consumption among all children, lunchtime vegetable consumption among girls, and daily fruit consumption as well as the proportion of total daily calories attributable to fruits and vegetables.

TABLE 3—Effect Modification at Follow-Up in Winter 1996 for Total Dietary Intake of Fifth-Grade Students in St. Paul, Minn: 24-Hour Recalls

Variable	Intervention Mean	Reference Mean	Difference	95% Confidence Interval	P
Vitamin C, mg					
Male	94.65	107.54	−12.89	−37.48, 11.69	.29
Female	136.33	108.60	27.73	4.50, 50.95	.02
Fat, % of calories					
Asian	27.66	32.64	−4.98	−2.65, −7.30	.00
African American	31.25	33.50	−2.25	−5.48, 0.97	.17
Hispanic	35.52	30.57	4.95	−0.53, 10.42	.09
White	30.45	31.02	−0.57	−2.34, 1.19	.52
Saturated fat, % of calories					
Asian	10.50	12.24	−1.74	−2.78, −0.72	.00
African American	11.56	13.31	−1.75	−3.23, −0.26	.03
Hispanic	14.86	12.35	2.51	−0.11, 5.13	.06
White	11.93	12.05	−0.12	−0.86, 0.61	.75
Folacin, μg					
Asian	240.30	216.74	23.59	−23.34, 70.54	.31
African American	274.37	233.71	40.66	−26.11, 107.42	.23
Hispanic	170.59	296.03	−125.44	−241.50, −9.38	.04
White	273.79	292.23	−18.44	−53.14, 16.26	.30

Note. Values were adjusted for baseline measures and age. The student sample size was 407. Differences between conditions are based on the F(1, 18) statistic for gender analyses and the F(1, 54) statistic for race/ethnicity analyses.

TABLE 4—Self-Reports of Fifth-Grade Students in St. Paul, Minn, at Follow-Up in Winter 1996: Health Behavior Questionnaire

Variable (Response Categories)	No. Items	Cronbach α	Possible Range	Intervention Mean	Reference Mean	Difference	95% Confidence Interval	P
How often do you ask to have F&V (at specific times)? (1 = never, 5 = always)	8	.84	8–40	25.64	23.86	1.78	0.17, 3.38	.03
Did you eat this (specific) food yesterday?(yes/no)	13	.67	0–13	4.95	4.73	0.22	−0.14, 0.58	.22
How many servings of fruits, fruit juices, or vegetables do you usually eat each day? (1 = 1, 6 = 6 or more)	1	. . .	1–6	4.14	3.33	0.81	0.58, 1.04	.00
How often do your parents/brother or sister eat F&V? (1 = never, 5 = always)	4	.69	4–20	14.94	14.81	0.13	−0.19, 0.44	.40
Who wants you to have F&V (at specific times)? (teacher)	8	.92	0–8	4.40	2.74	1.66	1.11, 2.21	.00
Who wants you to have F&V (at specific times)? (your friends)	8	.90	0–8	2.01	1.92	0.09	−0.64, 0.82	.79
Who wants you to have F&V (at specific times)? (the cooks at school)	8	.92	0–8	2.75	2.48	0.27	−0.49, 1.03	.47
Which of these two (specific) foods would you choose to eat? (fruit or vegetable, other choice)	6	.65	0–6	3.18	2.79	0.39	−0.04, 0.83	.08
How many servings of F&V do you think a person should eat each day for good health? (1 = 1, 6 = 6 or more)	1	. . .	1–6	5.03	4.49	0.55	0.39, 0.70	.00

Note. Values were adjusted for baseline measures and age, gender, and race/ethnicity. Student sample sizes ranged from 1028 (How often do you ask . . . ?) to 1271 (Which of these two foods . . . ?). Differences between conditions are based on the F(1, 18) statistic. F&V = fruits and vegetables.

Three important questions emerge: Why did fruit consumption change more readily than vegetable consumption? Why were there better results at lunch than over the entire day? Why were girls more responsive?

Fruit consumption (including both juice and fruits) may have been more likely to change than vegetable consumption because of differences in availability, ease, or attractiveness. Fresh fruit and raw vegetables were offered as alternatives to canned fruit and cooked vegetables. Fruits, however, were also offered at lunch as an alternative to baked desserts, which meant that additional fruits were actually available to the interven-

TABLE 5—Self-Reports of Parents of Fifth-Grade Students in St. Paul, Minn, in Winter 1996: Parent Telephone Survey

Variable (Response Categories)	No. Items	Cronbach α	Possible Range	Intervention Mean	Reference Mean	Difference	95% Confidence Interval	P
Do you have (specific F/V) in your home at this time? (yes/no)	13	.60	0–13	7.24	7.57	–0.32	–0.79, 0.14	.16
How many servings of F&V do you think a person should eat each day for good health? (open ended)	1	. . .	. . .	3.81	3.55	0.26	–0.12, 0.64	.17
Have you heard of the program "Five-a-Day for Better Health"? (yes/no)	1	. . .	0–1	0.84	0.58	0.26	0.14, 0.37	.00
On average, how many servings of F&V do you eat each day? (open ended)	1	. . .	. . .	3.24	3.20	0.04	–0.34, 0.43	.81
How important is it that your child eats 5 or more F&V every day? (0 = not at all important, 10 = very important)	1	. . .	0–10	8.10	8.12	–0.02	–0.32, 0.28	.87
Do you use any of the following (specific) methods to try to encourage your fifth grader to eat F&V? (yes/no)	7	.67	0–7	4.98	4.94	0.05	–0.39, 0.48	.83

Note. Values were adjusted for baseline measures; age, gender, and race/ethnicity of the student; gender of the parent; and parent's relationship to student. Parent sample sizes ranged from 321 to 324. Differences between conditions are based on the F(1, 18) statistic. F&V = fruits and vegetables.

tion school children. Fruits are generally easier to eat than vegetables because they mostly come in their own "packages."[36] Finally, fruits may be more appealing to children, since they are sweet and juicy.[37]

Fruit and vegetable consumption was more likely to change at lunch. The classroom program provided motivation, through group contests, for children to choose fruits and vegetables at lunch each day during the intervention period. The food service program provided additional opportunities for fruits and vegetables to be chosen. A parallel intervention at home was not possible, even though information, recipes, and snack packs were designed to facilitate changes at home. Similar results were noted in the Child and Adolescent Trial for Cardiovascular Health, in which fat consumption was more likely to change during meals eaten at school.[38] These results clearly suggest that the combination of classroom and food service programs in schools can make a difference in children's eating habits; the findings also underscore the difficulty in making changes in homes and the importance of creating new and more potent strategies for parental involvement.

Girls appeared to be more receptive than boys to increasing their vegetable consumption. Girls have been shown to be more receptive to other health education programs concerning eating patterns and physical activity.[39] Since dieting is a concern far more prevalent among female than male adolescents,[40] perhaps the intervention, even without any low-calorie message about vegetables, heightened interest in dieting—and thereby vegetables—even in our preadolescent population.

The secondary outcomes also revealed interesting changes. Although there were no changes in these variables evident through lunch observations, fat consumption was lower among intervention students in the 24-hour food recalls, particularly Asian-American and African-American students. Since the 24-hour recalls revealed only increased fruit consumption, and since there were no gender or ethnic differences in that variable, it is difficult to explain how the intervention, which focused on fruits and vegetables, might have contributed to lower fat consumption only among Asian-American and African-American children. The children and their parents may have generalized the intervention as involving "a healthy diet" and substituted fruit for higher-fat foods at meals or as snacks. Nader et al.[41] found that parent involvement in the Child and Adolescent Trial for Cardiovascular Health had the most impact with African-American boys, which does suggest differential receptivity. Alternatively, reporting bias may have been responsible, since the 24-hour recalls were entirely the students' self-reports.

The 5-a-Day Power Plus program used a creative, behavioral, multi-component intervention to improve the fruit and total fruit and vegetable consumption of urban children in St. Paul. To further our success in preventing cancer by promoting "5-a-Day," it is important to find methods to increase the appeal and availability of vegetables for children, particularly boys, as well as to increase the involvement of parents in these efforts. Environmental changes, such as those that were implemented in the school cafeterias, need to be encouraged at home. □

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References

1. Block G, Patterson B, Subar A. Fruit, vegetables, and cancer prevention: a review of the epidemiological evidence. *Nutr Cancer.* 1992;18:1–29.

2. Steinmetz KA, Potter JD. Vegetables, fruit, and cancer. I. Epidemiology. *Cancer Causes Control.* 1991;2:325–357.
3. Steinmetz KA, Potter JD. Vegetables, fruit, and cancer. II. Mechanisms. *Cancer Causes Control.* 1991;2:427–441.
4. Steinmetz KA, Potter JD. Vegetables, fruit, and cancer prevention: a review. *J Am Diet Assoc.* 1996;96:1027–1039.
5. US Dept of Health and Human Services. *Healthy People 2000: Midcourse Review and 1995 Revisions*. Washington, DC: Public Health Service; 1996.
6. Krebs-Smith SM, Cook A, Subar A, Cleveland L, Friday J. US adults' fruit and vegetable intakes, 1989 to 1991: a revised baseline for the *Healthy People 2000* objective. *Am J Public Health.* 1995;85:1623–1629.
7. Kann L, Warren CW, Harris WA, et al. Youth risk behavior surveillance—United States. *MMWR Morb Mortal Wkly Rep.* 1995;44(SS-1):1–55.
8. Krebs-Smith SM, Cook A, Subar A, Cleveland L, Friday J, Kahle LL. Fruit and vegetable intakes of children and adolescents in the United States. *Arch Pediatr Adolesc Med.* 1996;150:81–86.
9. Freeman HP. Cancer in the socioeconomically disadvantaged. *CA Cancer J Clin.* 1989;39: 266–288.
10. Winkleby MA, Jatulis DE, Frank E, Fortmann SP. Socioeconomic status and health: how education, income, and occupation contribute to risk factors for cardiovascular disease. *Am J Public Health.* 1992;82:816–820.
11. Neumark-Sztainer D, Story M, French S. Covariates of unhealthy weight loss behaviors and other high risk behaviors. *Arch Pediatr Adolesc Med.* 1996;150:304–308.
12. Havas S, Heimendinger J, Reynolds K, et al. 5-a-Day for Better Health: a new research initiative. *J Am Diet Assoc.* 1994;94:32–36.
13. Committee on Diet and Health, Food and Nutrition Board, National Research Council. *Diet and Health: Implications for Reducing Chronic Disease Risk*. Washington, DC: National Academy Press; 1989.
14. Kelder SH, Perry CL, Klepp K-I, Lytle LA. Longitudinal tracking of adolescent smoking, physical activity, and food choice behaviors. *Am J Public Health.* 1994;84:1121–1126.
15. Domel SB, Leonard SB, Baranowski T, Baranowski J. "To be or not to be . . ." Fruits and vegetables. *J Nutr Educ.* 1993;25:352–358.
16. Domel SB, Baranowski T, Davis H, et al. Development and evaluation of a school intervention to increase fruit and vegetable consumption among fourth and fifth grade students. *J Nutr Educ.* 1993;25:345–349.
17. Lytle LA, Achterberg CL. Changing the diet of America's children: what works and why? *J Nutr Educ.* 1995;27:250–260.
18. Contento I, Balch GI, Bronner YL, et al. The effectiveness of nutrition education and implications for nutrition education policy, programs and research: a review of research. *J Nutr Educ.* 1995;27:297–369.
19. Parcel GS, Kelder SH, Basen-Engquist K. The school as a setting for youth health promotion. In: Poland B, Green LW, Rootman I, eds. *Settings for Health Promotion: Linking Theory and Practice.* Thousand Oaks, Calif: Sage Publications. In press.
20. Luepker RV, Perry CL, McKinley SM, et al. Outcomes of a field trial to improve children's dietary patterns and physical activity: the Child and Adolescent Trial for Cardiovascular Health (CATCH). *JAMA.* 1996;275:768–776.
21. Bandura A. *Social Learning Theory*. Englewood Cliffs, NJ: Prentice Hall; 1977.
22. Bandura A. *Social Foundations of Thought and Action*. Englewood Cliffs, NJ: Prentice Hall; 1986.
23. Perry CL, Jessor R. The concept of health promotion and the prevention of adolescent drug abuse. *Health Educ Q.* 1985;12:169–184.
24. Perry CL, Story M, Lytle LA. Promoting healthy dietary behaviors. In: Weissberg RP, Gullotta TP, Adams GR, Hampden RL, Ryan BA, eds. *Healthy Children 2010: Strategies to Enhance Social, Emotional, and Physical Wellness*. Thousand Oaks, Calif: Sage Publications; 1997.
25. Perry CL, Luepker RV, Murray DM, et al. Parent involvement with children's health promotion: a one-year follow-up of the Minnesota Home Team. *Health Educ Q.* 1989; 16:1156–1160.
26. Lytle LA, Nichaman M, Obarzanek E, et al. Validation of 24-hour recalls assisted by food records in third grade children. *J Am Diet Assoc.* 1993;93:1431–1436.
27. Feskanich D, Buzzard IM, Welch BT, et al. Comparison of a computerized and a manual method of food coding for nutrient intake studies. *J Am Diet Assoc.* 1988;88:1263–1267.
28. Smiciklas-Wright HA, Mitchell DC, Norton LD, Derr JA. Interviewer reliability of nutrient intake data from 24-hour recalls collected using the Minnesota Nutrition Data System (NDS). *J Am Diet Assoc.* 1991;91:28A. Abstract.
29. Lytle LA, Murray DM, Perry CL, Eldridge AL. Validating students' self-report of dietary intake: results from the 5-a-Day Power Plus program. *J Am Diet Assoc.* In press.
30. Smith SA, Campbell DR, Elmer PJ, Martini MC, Potter JD. The University of Minnesota Cancer Prevention Research Unit vegetable and fruit classification (United States). *Cancer Causes Control.* 1995;6:292–302.
31. Zucker DM. An analysis of variance pitfall: the fixed effects analysis in a nested design. *Educ Psychol Meas.* 1990;50:731–738.
32. Murray DM, Hannan PJ. Planning for the appropriate analysis in school-based drug-use prevention studies. *J Consult Clin Psychol.* 1990;58:458–468.
33. *SAS/STAT Software: Changes and Enhancements, through Release 6.11*. Cary, NC: SAS Institute Inc; 1996.
34. Murray DM, Wolfinger RD. Analysis issues in the evaluation of community trials: progress toward solutions in SAS/STAT MIXED. *J Community Psychol.* 1994;(special issue): 140–154.
35. Murray DM, Hannan PJ, Baker WL. A Monte Carlo study of alternative responses to intraclass correlation in community trials: is it ever possible to avoid Cornfield's penalties? *Eval Rev.* 1996;20:313–337.
36. Basch CE, Zybert P, Shea S. 5-a-day: dietary behavior and the fruit and vegetable intake of Latino children. *Am J Public Health.* 1994; 84:814.
37. Kirby SD, Baranowski T, Reynolds KD, Taylor G, Binkley D. Children's fruit and vegetable intake: socioeconomic, adult-child, regional, and urban-rural influences. *J Nutr Educ.* 1995;27:261–271.
38. Nicklas T, Dwyer J, Mitchell P, et al. Impact of fat reduction on micronutrient density of children's diets: the CATCH study. *Prev Med.* 1996;25:478–485.
39. Perry CL, Kelder SH, Klepp K-I. Community-wide cardiovascular disease prevention with young people: long-term outcomes of the Class of 1989 Study. *Eur J Public Health.* 1994;4: 188–194.
40. Neumark-Sztainer D, Story M, Resnick MD, Blum R. Correlates of inadequate fruit and vegetable consumption among adolescents. *Prev Med.* 1996;25:497–505.
41. Nader PR, Sellers DE, Johnson CC, et al. The effect of adult participation in a school-based family intervention to improve children's diet and physical activity: the Child and Adolescent Trial for Cardiovascular Health (CATCH). *Prev Med.* 1996;25:455–464.